Preference of Sorghum Midge Among Selected Sorghum Lines, With Notes on Overwintering Midges and Parasite Emergence

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Preference of Sorghum Midge Among Selected Sorghum Lines, With Notes on Overwintering Midges and Parasite Emergence

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Grain sorghum is an increasingly important food crop. Approximately 30 million tons are produced annually. The sorghum midge (*Contarinia sorghicola* (Coquillett)) destroys up to 90 percent of a given sorghum crop. The need for entomologists and plant breeders to search for germ plasm resistant to the midge was reported by Painter (*4*),[2] Harris (*3*), and Wiseman and McMillian (*6, 7*). Since the use of resistant sorghums has received little attention, previous gains in this area of control have been meager. Harris (*2*), Harding (*1*), and Wiseman and McMillian (*6*) have reported resistance in sorghums, but the resistance mechanisms were not mentioned per se. Apparently preference did exist in the studies of Harris (*2*) and Wiseman and McMillian (*6*).

This study was designed to evaluate the preference mechanism of resistance in 10 selected lines of grain sorghum, which varied in degree of resistance. In addition, data on overwintering midges and parasitism were collected.

Materials and Methods

Ten lines of grain sorghum were selected in 1968 from 180 lines evaluated since 1963. Selection was based on previous resistance ratings, and lines were included that ranged from resistant to extremely susceptible to the sorghum midge. All lines were planted in single-row plots 15 feet long in a complete randomized block design with five replications for each of five plantings in 1968 and 1969. The first planting was on May 15 and the last on July 9.

Visual ratings of damage were made on five individual sorghum heads of each line as soon as the

[1] Appreciation is extended to Winfred N. Roberson for both entomological and agronomic assistance during this study.

[2] Italic numbers in parentheses refer to Literature Cited, p. 8.

late flowering lines in each planting had set or failed to set seed. The rating scale used was that of Wiseman and McMillian (*7*), where 0 = no damage, 1 = 1–10 percent of head damaged, and 2–10 = 11–100 percent of head damaged. Flowering dates of each line were recorded when 10 percent flowering was apparent on 50 percent of the plants per plot. An average flowering date for the five replications for each planting is presented for 1969.

In 1968, five heads from each line at approximately the same blooming period were excised, caged, and observed until the adult midge began emerging from the caged heads (*6*). Midges were removed daily and counted. Evaluations from 13 collections of sorghum heads were made.

In 1969, samples of five heads from each line from each of the second through the fifth plantings were selected at random from each replicate. Samples from the first planting were omitted because very little damage occurred on a few lines. Thirty damaged seeds from each sample were dissected to determine the presence or absence of overwintering midges, number of emergence holes through the seed tip, and number of parasite exit holes. These parasite exit holes (*8*) were erroneously called midge emergence holes by Wiseman and McMillian (*6*).

The analysis of variance and Duncan's multiple range test were used for both field and laboratory experiments to detect statistically significant differences. Tests of homogeneity were made for the field ratings of the five plantings for each year. The use of homogeneous error mean square allowed the tests to be combined and the results of the five plantings to be compared in an overall analysis of variance.

Results and Discussion

The sorghum midge began its activity the last part of June in 1968 and after July 10 in 1969 at Tifton, Ga. In 1968, populations fluctuated, and two major peaks occurred as measured by the number of midges that emerged from caged excised heads of a susceptible line. These peaks were observed about July 25 and August 15. In 1969, populations appeared more constant, but by using a system of sticky traps to record the numbers caught, catches on August 10 and 25 were each almost double compared to any other single catch.

The tests reported in table 1 are possibly the first demonstration of utilizing a "manipulated artificial" infestation of the sorghum midge. Early sorghum plantings were made, and the midge population increased and maintained itself on subsequent sorghum plantings. Thus ade-

quate midges were constantly available to show differential damage in sorghum lines in the tests. We then evaluated for "real" resistance; the likelihood of encountering escapes was negligible.

When the midges were present in damaging numbers, all flowering lines from July 26 to August

TABLE 1.—*Effect of planting date on preference of sorghum midge for sorghum lines selected for varying degrees of resistance as shown by damage ratings and midge emergence, Tifton, Ga., 1968 and 1969* [1]

Year and line	Damage rating by planting date					Average	Midge emergence per caged head [2]
	May 17	May 31	June 14	June 24	July 3		
1968							
ODC19 (select)	5.2 ab	4.2 a	4.2 a	3.0 a	5.6 a	4.4 a	0.3 a
ODC19	6.4 b	4.0 a	3.8 a	4.8 b	6.0 a	5.0 a	.2 a
GA615	4.6 a	9.4 c	9.2 bc	9.0 cd	5.8 a	7.6 b	12.4 bc
CI810 Feterita	9.2 c	7.6 b	8.2 b	8.6 cd	8.8 b	8.5 bc	7.2 b
SA216 Kafir	9.4 c	9.2 c	9.0 bc	8.0 c	8.4 b	8.8 bc	9.7 bc
CI71 Kafir	9.8 c	9.6 c	9.6 c	8.6 cd	8.6 b	9.2 c	6.4 b
FC16208 (Club)	9.6 c	9.4 c	9.6 c	9.6 cd	9.6 b	9.2 c	6.9 b
FC16188 (Grohoma)	8.4 c	9.6 c	9.6 c	9.8 d	8.2 b	9.5 c	15.3 bc
CI938 Durra	10.0 c	10.0 c	10.0 c	9.8 d	9.4 b	9.7 c	25.5 cd
SPI29166 (Freed) Kaoling	9.8 c	10.0 c	10.0 c	9.8 d	10.0 b	9.9 c	52.2 d
	May 15	May 28	June 12	June 24	July 9		
1969							
ODC19 (select)	0.1 a	1.1 a	4.5 a	6.1 a	1.7 a	2.7 a	----------
ODC19	1.3 bc	3.4 bc	5.8 b	8.4 b	2.5 a	4.3 ab	----------
CI810 Feterita	1.0 ab	2.6 ab	7.4 c	8.4 b	4.9 b	4.9 bc	----------
GA615	1.6 c	2.9 b	6.3 b	8.5 b	8.7 e	5.6 cd	----------
FC16208 (Club)	2.1 c	3.5 bc	8.0 c	8.8 bc	7.6 de	6.0 cd	----------
SA216 Kafir	1.1 bc	5.8 d	9.0 de	8.7 bc	6.2 c	6.2 cd	----------
CI71 Kafir	1.4 bc	5.3 d	9.0 de	8.7 bc	7.0 cd	6.3 d	----------
FC16188 (Grohoma)	1.4 bc	4.8 cd	8.1 cd	9.4 bc	8.9 e	6.5 d	----------
CI938 Durra	.4 ab	8.2 e	9.2 e	9.6 c	8.9 e	7.3 d	----------
SPI29166 (Freed) Kaoling	.4 ab	8.0 e	9.8 e	9.4 bc	9.0 e	7.3 d	----------

[1] Rating scale for damage was 0 = no damage, 1 = 1–10 percent of sorghum head damaged, and 2–10 = 11–100 percent of head damaged. Averages followed by same letter are not significantly different at 5-percent level as determined by Duncan's multiple range test.

[2] 1 was added to each average, then natural log was used in analysis.

4 in one of the five plantings were recorded to determine whether preference was involved. Figure 1 illustrates the relationship of ODC19 (select), the nonpreferred line; GA615, an intermediate line; and SPI29166, the highly preferred line. When the midges were in damaging numbers, SPI29166 was almost completely destroyed. As populations increased, GA615 and ODC19 (select) also had increased damage inflicted. In general, in each succeeding planting, ODC19 (select) was damaged progressively more; however, the damage was relatively less compared with that to susceptible entries.

The midge populations seemed to have increased to a level that they did not discriminate among

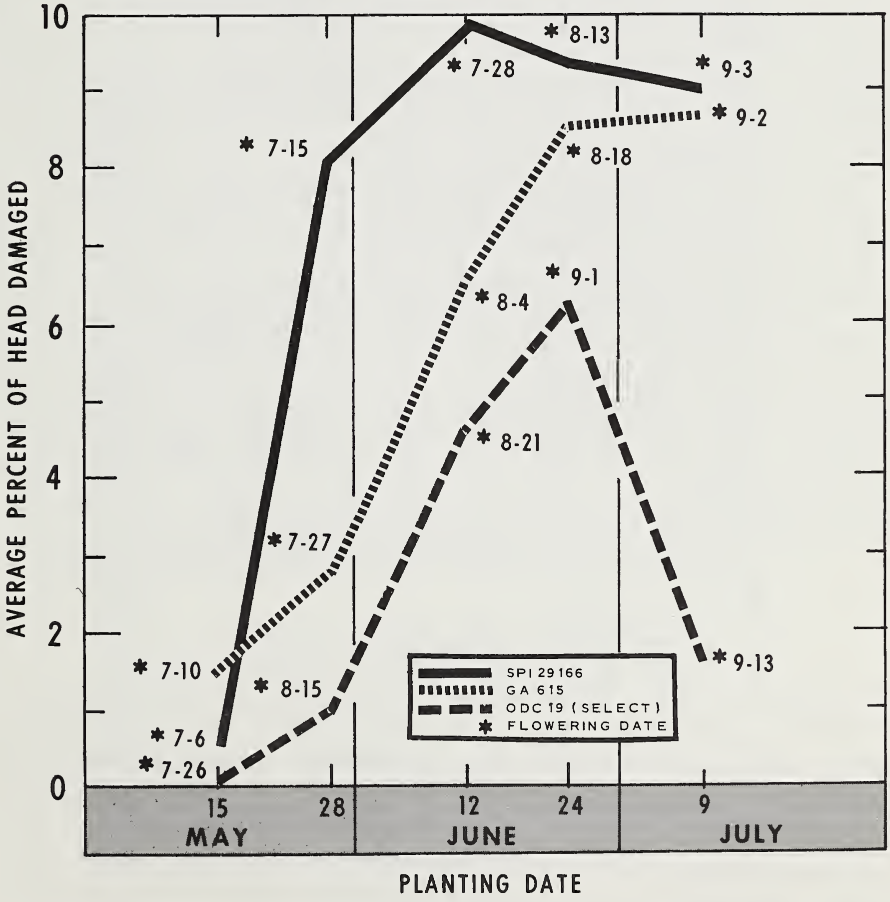

FIGURE 1.—Damage, planting date, and flowering period of three selected sorghum lines, showing preference of sorghum midge, 1969.

TABLE 2.—*Overwintering midges and parasite exit holes per 30 damaged seeds in resistant and susceptible sorghum lines in 4 plantings, Tifton, Ga., 1969* [1]

Line	May 28 planting		June 12 planting		June 24 planting		July 9 planting		Average	
	Over-wintering midges	Parasite exit holes	Over-wintering midges	Parasite exit holes	Over-wintering midges	Parasite exit holes	Over-wintering midges	Parasite exit holes	Over-wintering midges	Parasite exit holes
	Number	*Number*	*Number*	*Number*	*Number*	*Number*	*Number*	*Number*	*Number*	*Number*
ODC19 (select)	15.0 e	4.2 ab	2.6 a	6.6 de	5.0 a	5.4 d	2.0 a	0.6 a	6.2	4.2
CI938 Durra	10.8 de	3.8 a	3.6 ab	1.8 a	4.0 a	1.0 a	2.8 a	6.8 d	5.3	3.4
FC16208 (Club)	5.6 b	4.2 ab	7.2 b	3.8 abc	10.2 cd	4.4 cd	2.8 a	1.4 ab	6.5	3.6
FC16188 (Grohoma)	2.6 a	6.0 b	7.6 b	3.4 ab	9.4 cd	2.6 b	4.0 a	1.8 ab	5.9	3.5
CI71 Kafir	9.8 d	3.4 a	7.8 bc	8.0 e	11.4 de	5.0 d	3.2 a	4.8 c	8.1	5.3
SPI29166 (Freed) Kaoling	5.0 ab	5.0 ab	11.0 cd	5.8 cd	5.0 a	3.0 bc	9.4 b	1.6 ab	7.6	3.9
ODC19	9.0 d	5.6 ab	11.6 cd	8.8 e	4.4 a	4.0 bcd	4.4 a	2.2 ab	7.4	5.2
GA615	10.2 d	5.2 ab	14.8 de	5.6 bcd	8.4 bc	2.4 ab	11.2 c	4.6 c	11.2	4.5
SA216 Kafir	4.4 ab	5.2 ab	16.2 e	1.8 a	13.2 e	3.0 bc	8.6 b	3.0 bc	10.6	3.2
CI810 Feterita	8.6 cd	4.2 ab	17.8 e	1.8 a	6.4 ab	3.8 bcd	1.8 a	1.8 ab	8.7	2.9
Average	8.1	4.68	10.0	4.74	7.74	3.46	5.02	2.86	--------	--------
Percent	27.0	15.6	33.0	15.8	25.8	11.5	16.7	9.5	25.6	13.1

[1] Averages followed by same letter are not significantly different at 5-percent level as determined by Duncan's multiple range test. Averages are based on 150 damaged seeds, 30 per replicate for 5 replications.

most lines in the last plantings. Thus two types of preference (*5*) were demonstrated. The midges preferred the highly susceptible line when given a choice, and when the population increased and all lines were heavily damaged, little or no discrimination was exhibited by the midges.

In 1968, excised heads of all lines were caged and the emerged midges were collected daily. An average of 13 such collections indicated that ODC19 (select) and ODC19 were by far the least preferred by the midge. However, using this criterion alone may be misleading, because the seed may be damaged while parasites destroyed the midge larvae, or a deleterious effect by the plant may have delayed the insect's life or destroyed it after the embryo had been consumed by the larvae. When the two criteria—emerging midge from the damaged seed and visual damage ratings—were utilized, the midges' nonpreference for ODC19 (select) and ODC19 and preference for SPI29166 and CI938 were separable.

As shown in table 2, the nonpreferred line ODC19 (select) was also among the lines with the fewest overwintering midges. This same line had a greater number of parasite exit holes. The parasitic wasps were identified as *Aprostocetus diplosidis* Crawford and *Tetrastichus venustus* Gahan. *A. diplosidis* appeared to be much more prevalent than *T. venustus.*

Up to one-third of each generation of midges apparently overwinters. Overwintering midges were present in the damaged seeds in larger numbers in earlier plantings than in later plantings. The number of parasite exit holes was counted from samples of each line in each planting. Assuming that this criterion was indicative of the relative amount of parasitism, the number of midges parasitized in any one planting was not greater than 16 percent. However, other midge parasites (*8*) may have been present and emerged as the adult midges did through the seed tip.

Summary

The adult sorghum midge (*Contarinia sorghicola* (Coquillett)) prefers certain lines of sorghum (SPI29166 and CI938) over others, such as ODC19 (select), even under heavy infestations. However, when the midges were abundant, they apparently did not discriminate among most sorghum lines. Up to one-third of the midge population overwintered in each of the four plantings. Damaged seeds with parasite exit holes were only 13 percent of the total destroyed seeds, indicating a low level of parasitism.

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